Quantitative Assessment of Sea Otter Benthic Prey Communities within the Olympic Coast National Marine Sanctuary: 1999 Re-survey of 1995 and 1985 Monitoring Stations

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Abstract

This report summarizes the changes in the distribution and abundance of selected benthic species within sea otter prey communities along the Washington State Olympic coast between 1987 and 1999. During this 12 year period, the Washington otter population has undergone a dramatic increase in both numbers and range, now occupying habitats that were otter free when first sampled in 1987. Quantitative video and *in situ* counts taken of invertebrate prey and algal cover at monitoring sites established along the coast in 1987, 1995, and 1999 reveal significant changes occurring as sea otters expanded their range into previously unexploited habitats. Invertebrate prey such as commercially harvested sea urchins that were abundant just outside the boundaries of the 1987 sea otter range are now virtually absent along the entire outer rocky coast. Understory foliose red, coralline, and brown algal cover have also undergone changes as otters removed large invertebrate grazers from the newly occupied habitats.

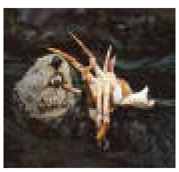
Hypotheses

H_1: As the Washington State sea otter population continues to grow, it will expand north, drawn by and depleting the rich prey resources found there.

H_2: If sea otters move into northern habitats, significant changes in benthic algal cover will occur with reduced abundance of sea urchins and other invertebrate grazers.

H_3: Sea otters will be slower to colonize areas with higher water velocities resulting in a higher prey biomass in those areas.

Introduction



Sea otters *(Enhydra lutris)* were reintroduced to the Washington coast from Alaska during 1969-70 (Jameson *et al*. 1982). Since that time, particularly over the last decade, the sea otter population has expanded dramatically, from the initial translocation of 59 individuals (Jameson *et al*. 1982), to 100 animals in 1987 (Bowlby *et al*. 1988), >300 in 1995 (Jameson, National Biological Survey), and 605 in 1999 (Jameson and Jefferies 1999).

Here we report the results from our June 1 through 12, 1999 resurvey of the 1987 and 1995 study sites. Our goal was to see if the invertebrate and algal trends seen in 1995 were continuing with the growth of the Washington sea otter population. Of particular interest was whether or not the remnant population of abundant large sea urchins found in 1995 in the high current areas of Cape Flattery and Tatoosh Island were still intact after several years of otter occupancy.

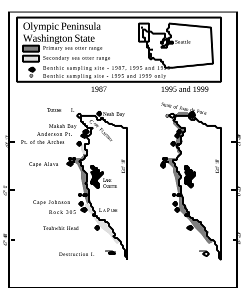


Figure 1: Benthic sampling sites and the sea otter ranges for 1987, 1995 and 1999 along the Olympic coast of Washington State. Methods and data for determining primary otter range (> 3 otters observed per survey) and secondary otter range (<1 otter observed per survey) come from Bowlby et al. 1988, and Jameson National Biological Survey unpublished data.

Methods

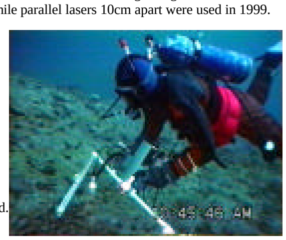
1987 Sampling Techniques:

- Study sites from North to South: Neah Bay, Makah Bay, Anderson Point, Pt. of Arches, Cape Alava, Cape Johnson, Rock 305 and Teahwhit Head (Fig. 1).
- Divers counted and measured invertebrates and percent algal cover within 1 m^2 quadrats deployed along 14 meter transect lines.

1995 and 1999 Sampling Techniques:

- Additional sites were added: Tatoosh Island and Cape Flattery.
- Surveys were conducted from aboard the R/V *Tatoosh*.
- Video quadrat techniques were used to sample all sites (Sony Hi8 camera in an underwater housing).
- Two PVC pods were placed on the camera housing, so a field of view of 0.25 m^2 was generated when the pods were placed on the seafloor.
- The operator was thus able to move across the seafloor with the camera running continuously, pausing momentarily to push the pods against the substrate, capturing 0.25 m^2 video images for later analysis.
- To aid in the measuring of individuals on the video display, a 20 cm long scale bar was placed in the field of view at the beginning and end of each quadrat series in 1995 while parallel lasers 10cm apart were used in 1999.

Video Processing:



- Videotapes were viewed in the laboratory, where benthic invertebrate species were identified, counted, and measured.
- Invertebrate prey biomass was determined based on size/weight regression formulae derived during the 1987 survey project.
- Only conspicuous, exposed otter prey items were counted, as divers did not disturb the substrate (therefore, cryptic or hidden prey may have been overlooked).
- Percent cover of substrate type was determined by superimposing a random pattern of 50 dots on the image; layering was not accounted for, as only the uppermost visible substrate type was recorded.
- Statistical comparisons of all three sampling years were run using the Kruskal-Wallace test.
- The Mann-Whitney test was used to test for significant changes occurring between 1995 and 1999.

Comparison of 1987 and 1995 Sampling Techniques:

- In 1995 a test comparison was conducted at Chibahdehl Rocks to compare invertebrate size and abundance data collected using both methods.
- Results showed no significant difference (t-tests, p = 0.32 and 0.24 for abundance and size, respectively).
- Power was not optimal but reasonably high for both of these comparison t-tests as well (power = 0.66 for abundance t-test, 0.67 for size t-test).

Sea Otter Data:

- Current sea otter distribution and abundance data was obtained from the National Biological Service Washington State census (Jameson and Jefferies 1999, unpublished data).

Results

In 1987 prey abundance and biomass was inversely proportional to sea otter abundance (Fig. 2a). By 1995, prey abundance and biomass remained low at the 1987 sea otter sites, and had declined dramatically at previously sampled sites recently invaded by sea otters (Fig. 2b). In 1995 Sea urchins had become rare or absent at all sites within the otter range, with one very notable exception, the highly exposed and current swept mouth of the Straits of Juan de Fuca (Fig. 2b). Here, Tatoosh Island and Cape Flattery both supported urchin numbers and biomass dramatically and significantly higher than at any other location (Kruskal-Wallis test p = 0.0005). By 1999, however, these last remaining pockets of high prey biomass with in the otter range were gone (Fig. 2c). For 1999, there was no significant difference in prey abundance between sites.

Foliose red, coralline and brown algal cover were followed at three sites, Neah Bay, Anderson Pt. and Cape Alava for all years (Figs. 3a, b, and c). Foliose red algal cover at Neah Bay has increased significantly from 0% in 1987 to 24% and 15% in 1995 and 1999 respectively (Kruskal-Wallis, p < 0.0001), while decreasing significantly at Anderson Pt. (Kruskal-Wallis, p < 0.0001), and dropping at Cape Alava (Kruskal-Wallis, p = 0.01)(Fig. 3a). The only significant difference in foliose red cover between 1995 and 1999 was the decline at Anderson Pt. (Mann-Whitney U-test, p < 0.0001). Coralline cover continued to drop dramatically and significantly at Neah Bay (100%, 44%, 1%)(Kruskal-Wallis, p < 0.0001, Mann-Whitney U-test p < 0.0001), and at Anderson Pt. (18%, 17%, 6%) (Kruskal-Wallis, p = 0.001, Mann-Whitney U-test p < 0.0001), while fluctuating slightly but significantly at Cape Alava (Kruskal-Wallis p = 0.001, Mann-Whitney U-test p = 0.0006 (Fig. 3b). Brown algae has increased steadily and significantly from 0 to 33% at Neah Bay since 1987 (Kruskall-Wallis p < 0.0001, Mann-Whitney U-test p = 0.009), fluctuated significantly between 4% and 34% at Anderson Point (Kruskall-Wallis p < 0.0001, Mann-Whitney U-test p < 0.0001), and did not change significantly at Cape Alava (Kruskall-Wallis p = 0.49, Mann-Whitney U-test p = 0.20), (Fig. 3c).

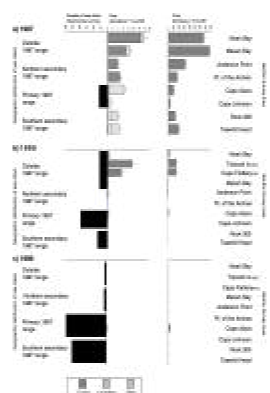


Figure 2: Invertebrate prey abundance at benthic sampling sites for 1987, 1995 and 1999, related to sea otter abundance. HC = high current areas at Tatoosh Island and Cape Flattery. These two sites were sampled in 1995 and 1999 only.

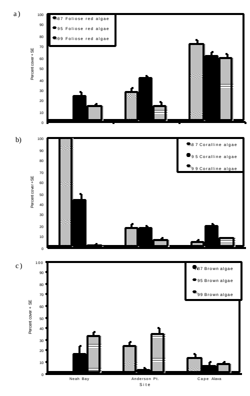
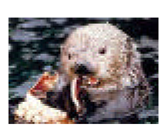


Figure 3: Changes in percent foliose red, coralline and brown algal cover following sea otter expansion from 1987 to 1999. N = number of 0.25m2 quadrats.

Conclusions

- Otter numbers have increased within their range since 1987, and their range has expanded to the north as predicted (H_1).
- Prey abundance and biomass have declined by an order of magnitude to very low levels at newly otter-occupied sites on either side of Cape Flattery by 1995, also as predicted (H_2).
- By 1999, the high prey numbers and biomass found at Cape Flattery and Tatoosh Island in 1995 had also dropped to levels comparable with the other monitoring site, refuting the high current prey refuge hypothesis (H_3).
- The removal of urchin grazers by sea otters was most likely responsible for the rise in cover of more palatable algae at the recently occupied Neah Bay and Anderson Pt. sites.
- The most dramatic change in algal cover occurred at Neah Bay, the site that experienced the greatest decline in urchin abundance following the movement of sea otters into the area.



Acknowledgments

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Citations

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